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(54) **POSITIONABLE GAS INJECTION NOZZLE ASSEMBLY FOR AN UNDERWATER PELLETIZING SYSTEM AND METHOD FOR PROCESSING EXTRUDABLE MATERIALS**

.POSITIONIERBARE GASINJEKTIONSDÜSENANORDNUNG FÜR EIN
UNTERWASSERPELLETIERSYSTEM UND VERFAHREN ZUR VERARBEITUNG VON
EXTRUDIERBAREN MATERIALIEN

ENSEMBLE DE BUSE D'INJECTION À GAZ POUVANT ÊTRE POSITIONNÉ POUR UN SYSTÈME
IMMERGÉ DE PASTILLAGE ET PROCÉDÉ POUR LE TRAITEMENT DES MATIÈRES EXTRUDABLES

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Description

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0001] The present invention relates generally to underwater pelletizing systems and, more particularly, to a gas injection nozzle for use with such systems.

2. DESCRIPTION OF RELATED ART

[0002] Those skilled in the art have found it beneficial, and sometimes necessary, to produce pellets that crystallize, either partially or fully. To help achieve that crystallization, the assignee of the present invention has disclosed the use of a nozzle through which pressurized air or other gas can be injected into the pellet slurry to help decrease the retention time of the pellets in the transportation liquid between the upstream pelletization process and the downstream drying and subsequent processes in U.S. Patent No. 7,157,032; U.S. Patent Application Publication Nos. 2005/0110182 and 2007/0132134; World Patent Application Publication Nos. WO 2005/051623, and WO 2006/127698, all of which are owned by the current assignee of the present invention.

[0003] Similarly, WO 2007/027877 discloses the use of a nozzle through which pressurized air or other gas can be injected into the pellet slurry to facilitate aspiration of the liquid from the pellets in the pellet slurry. Moisture content of the pellets is lowered by reducing the retention time of the pellets in the transportation liquid between the upstream pelletization process and the downstream drying and subsequent processes. The reduced retention time also results in more of the internal heat of the pellets formed being retained, and thus reduces the moisture available for uptake by the pellets. This application, also owned by the current assignee of the present invention.

[0004] Under certain conditions, pellets can clump or form agglomerates during the pelletizing process. The formation of pellet agglomerates can have many causes, of which sticky pellets is both common and frequent. When these agglomerates form they have the tendency to get caught in so-called "hang-up points", a term used herein to describe locations throughout the process where pellets and/or agglomerates of pellets tend to get hung-up and remain, often forming an obstructive build-up. As an example, agglomerates of pellets can form when "drooling", excessive flow of molten material through the die holes, occurs at the die plate, thus creating an undesirably large pellet. Large pellets are not the only problem. Pellets of desirable size can create a problem as well. Sticky pellets, or pellets that are still soft, that come into contact with the nozzle can be "smashed" and stick to the nozzle due to their stickiness and the velocities at which they are traveling. Eventually more and more pellets come into contact with those stuck on

the nozzle and pellets begin to adhere to each other creating a mass of pellets, also referred to as an agglomerate. Eventually the mass of pellets can become large enough to disrupt the flow of transport liquid and pellets through the transport pipe. This disruption can force the pelletization process to be stopped.

[0005] One such hang-up point has been found to exist in pelletization lines utilizing the apparatus and process of inserting pressurized gas described in the afore-identified patents and applications, namely the point at which the gas insertion nozzle is located within the pellet transport pipe. According to these prior embodiments, the nozzle used to inject the air is as illustrated in Figure 1 and generally designated by the reference numeral 200. The prior art fixed nozzle tube 210 is attached, preferably by welding, into elbow 202 at juncture 214. This fixed nozzle assembly 200 cannot be removed to facilitate start-up. It can further serve as a potential source for occlusion by pellet agglomeration as it cannot be maneuverably positioned to permit free flow of the pellet slurry about the periphery of the fixed nozzle pipe 210. Similarly, the fixed position limits the degree to which the air or other gas being injected can be controlled through valve regulation.

[0006] Therefore, a need exists for a positionable nozzle that can be adjusted to optimize the crystallization and/or drying of pellets produced by an underwater pelletizing system.

SUMMARY OF THE INVENTION

[0007] In view of the foregoing, it is an object of the present invention to provide a positionable nozzle through which pressurized gas is introduced into the transport apparatus of an underwater pelletizer to increase the velocity of a pellet slurry being transported from a pelletizing process to and through a drying process while controlling the dynamics of the slurry flow through changes in the position of the nozzle.

[0008] Another object of the present invention is to provide a positionable nozzle having a nozzle tube and collar that slides within a housing attached to a seal transition collar and affixed to an elbow within the transport pathway between the pelletization apparatus and the drying apparatus.

[0009] Still another object of the present invention is to provide a positionable nozzle in accordance with the preceding objects that is adjustable between at least a fully inserted or forward position and a fully retracted position, with positioning of the nozzle to make such adjustment being accomplished manually or by means of an automated control system that uses mechanical, pneumatic, hydraulic, electrical, electronic or other methods, singularly or in combination, as may be suitable for a particular application.

[0010] A still further object of the present invention is to provide a positionable nozzle in accordance with the preceding objects that can be manually or automatically adjusted using any of the methods set forth in the imme-

diately preceding object to inject pressurized gas in one or more intermediate or partially inserted positions.

[0011] A further object of the present invention is to provide a positionable nozzle in accordance with the preceding objects that is angularly positioned within the lumen of the elbow to which it is attached such that the angle ranges from approximately 0° from the centerline of the downstream assembly to a maximum angle defined by contact of the outside of the nozzle tube with the inside surface of that downstream assembly.

[0012] Yet another object of the present invention is to provide a positionable nozzle that is concentrically centered about the centerline of the downstream equipment.

[0013] Still a further object of the present invention is to provide a positionable nozzle through which pressurized gas is introduced that increases the velocity of a pellet slurry being transported from a pelletizing apparatus to and through a drying apparatus such that the internal heat of the pellets is retained to facilitate drying of the pellets such that the moisture content of the pellets leaving the drying apparatus is less than approximately 1.0% by weight, more preferably less than 0.5% by weight, and most preferably less than 0.25% by weight.

[0014] An additional object of the present invention is to provide a positionable nozzle through which pressurized gas is introduced to increase the velocity of a pellet slurry being transported from a pelletizing apparatus to and through a drying apparatus such that the internal heat of the pellets is retained to facilitate both drying and crystallization of the pellets.

[0015] A further object of the present invention is to provide a positionable nozzle in accordance with the preceding object through which pressurized gas is introduced that increases the velocity of a pellet slurry being transported from a pelletizing apparatus to and through a drying apparatus such that the pellets leaving the drying apparatus are crystallized at least 20% by weight, more preferably at least 30% by weight, and most preferably at least 40% by weight.

[0016] Yet a further object of the present invention is to provide a positionable nozzle that can be retracted at least partially to prevent pellet hang-up during start-up of the pelletization process, and that can be moved forward to expedite the flow of the pellet slurry into and through the transport pipe and to facilitate the aspiration of the transport liquid away from the pellets as they move through the transport pipe.

[0017] A still further object of the present invention is to provide a positionable nozzle having any of a number of cross-sectional shapes, inner surface variations or internal structures in order to produce specific desired effects on the flow of the pellet slurry.

[0018] In view of these and other objects, the present invention is directed to an injecting device according to claim 1 and a method according to claim 9. Preferably, the positionable nozzle assembly is configured so that the nozzle tube can be positioned, manually or through the use of an automated control system, at not only the

fully inserted and fully retracted positions but also at various intermediate positions between the fully inserted forward position and the fully retracted position.

[0019] These benefits together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Figure 1 is a cut-away and cross-sectional illustration of a prior art fixed nozzle configuration.

Figure 2 is a schematic illustration of an underwater pelletizing system including an underwater pelletizer and transport piping with a positionable nozzle connected to a centrifugal dryer in accordance with the present invention.

Figure 2a is an enlarged view illustration of the positionable nozzle of Figure 2.

Figure 3 is a cut-away and cross-sectional illustration of a portion of the positional nozzle and transport piping of Figure 2a with the nozzle tube in a retracted position.

Figure 4 is a cut-away and cross-sectional illustration of a portion of the positional nozzle and transport piping of Figure 2a with the nozzle tube in an inserted forward position.

Figure 5 is a schematic top view of a portion of the positional nozzle and transport piping of Figure 2a with the nozzle tube in the inserted forward position.

Figure 6a is a cut-away and cross-sectional illustration of a portion of the positional nozzle and transport piping of Figure 2a using an automated control system with the nozzle tube shown in a retracted position.

Figure 6b is a view of the nozzle tube housing taken along line 6b-6b of Figure 6a.

Figure 6c is a cut-away and cross-sectional illustration of the automated control system embodiment of Figure 6a with the nozzle tube shown in an inserted forward position.

Figure 6d is a view of the nozzle tube housing taken along line 6d-6d of Figure 6c.

Figure 7 is a partial cutaway view of a magnetically coupled rodless cylinder for use in the automated control system of Figures 6a-6d.

Figure 8 is a diagram showing a control circuit for the automated control system of Figures 6a-6d.

Figure 9a is an illustration of the forward orifice of a nozzle tube containing perpendicularly oriented straight fins in accordance with the present invention.

Figure 9b is an illustration of the forward orifice of a nozzle tube containing perpendicularly oriented contoured fins in accordance with the present invention.

Figure 9c is an illustration of a semicircular forward orifice for a nozzle tube in accordance with the present invention.

Figure 9d is an illustration of a conchoidal to C-shaped forward orifice for a nozzle tube in accordance with the present invention.

Figure 9e is an illustration of a nozzle tube with tapered terminus in accordance with the present invention.

Figure 9f is an illustration of a nozzle tube with a decreasingly conical tapered bore in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0021] Although preferred embodiments of the invention are explained in detail, it is to be understood that other embodiments are possible. Accordingly, it is not intended that the invention is to be limited in its scope to the details of constructions, and arrangement of components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being carried out in various ways. Also, in describing preferred embodiments, specific terminology will be resorted to for the sake of clarity. It is to be understood that each specific term includes all technical equivalents which operate in a similar manner to accomplish a similar purpose. Where possible, components of the drawings that are alike are identified by the same reference numbers.

[0022] The positionable nozzle assembly according to the present invention helps to enhance the crystallization of various polymeric materials and also facilitates drying of those and other materials while eliminating a possible hang-up point for agglomerates that has been encountered with prior designs. With pressurized air or other gas injected into the pellet transportation pipe, the velocity of the pellet slurry is increased. The result is a decrease in time that the pellets are subjected to the transport liquid due to that increased velocity as well as the aspiration of transport liquid away from the surface of those pellets. Due to the increased velocity, the retention time of the pellets in the transport liquid is less, allowing the pellets to retain more internal heat than had they been subjected to the transportation liquid for a longer period. In effect, it is the increase in retained internal heat that aids in the crystallization of the pellets. This effect is further enhanced by the aspiration of the transport liquid away from the surface of the pellets such that loss of heat to the transfer liquid is reduced.

[0023] To achieve the maximum throughput of the pellets, the present invention allows the geometry and positioning of the nozzle to be adjusted. This is important to the velocity at which the slurry is transported from the pelletizer to the dryer which, in turn, impacts the efficiency of the system in separating the pellets from the transport liquid by aspiration and increasing the amount of internal heat retained by the pellets. Changing the geometry and

positioning of the nozzle can also serve to alter the flow pattern of the slurry through the transport pipe, creating more or less turbulence to meet specific requirements associated with the material being processed.

[0024] Turning now to Figure 2, the positionable nozzle in accordance with the present invention, generally designated by the reference numeral 100, is assembled into the transport piping, generally designated by the reference numeral 15, that connects the pelletization apparatus 10 to the drying apparatus 20 and any subsequent post-processing. A melting and mixing apparatus, not shown, connects to the pelletizer 10 to which is attached inlet pipe 12. Transport liquid is introduced through inlet pipe 12 into the cutting chamber of pelletizer 10 where it mixes with the pellets to form the pellet slurry. The pellet slurry exits through outlet pipe 14 into and through sight glass 16 and then past the positionable nozzle assembly 100 in transport piping 15. A pellet speed expediter is injected and directed into the transport piping through the positionable nozzle assembly 100 to reduce the time the pellets are subjected to the transport liquid. The pellet speed expediter is preferably air in view of its inert nature and ready availability. However, other gases having inert characteristics such as nitrogen or similar gases could be used. The expedited pellet and transport liquid passes through transport pipe 18 into and through dryer assembly 20 wherein the pellets are dewatered and dried. Details of the expedited pellet and transport liquid follow below.

[0025] The melting and mixing apparatus, not shown, can be any prior known apparatus or combinations thereof and can include, without being limited thereto, melt vessels, single screw extruders, twin screw extruders, static mixers, continuous mixers, Banbury-type mixers, and the like as is known to those skilled in the art.

[0026] The pelletizer 10 can be a water ring pelletizer, an underwater pelletizer, and the like, and is preferably an underwater pelletizer fitted with an extrusion die as is well known to those skilled in the art. Transport liquid can be any liquid and is preferably water. In addition to water, other liquids useful in pelletization in accordance with the present invention include alcohol, water-alcohol mixtures, mineral oil, vegetable oils, glycol mixtures, etc. Optionally, the water or other transport liquid can contain additives including, but not limited to, flow modifiers, coatings, defoamers, cosolvents, and the like. As used herein, when references are made to "liquid" or "water" in connection with the transport liquid, such references are intended to refer to any liquid suitable for use as a transport liquid, with or without additives, and not just water.

[0027] The materials being pelletized and transported in accordance with the present invention can be polymers, waxes, and other extrudable materials that are conventionally processed by pelletization. As examples, the materials can include polyolefins, polyesters, polyethers, polythioethers, polyamides, polyamideimides, polysulfones, polycarbonates, polyurethanes, fluoropolymers, vinyl polymers, biodegradable polymers, and co-

polymers thereof. Materials that are typically crystallized before further processing are especially suitable for processing in accordance with the present invention, and preferably the materials can be dried to a moisture content of less than 1% by weight and crystallized to a level of at least 20%. Even more preferably, the materials can be dried to a moisture content less than 0.50% moisture by weight and crystallized to a level of at least 30% by weight, and most preferably the materials can be dried to a moisture content less than 0.25% by weight and crystallized to a level of at least 40% by weight.

[0028] Alternatively and optionally, the materials to be pelletized in accordance with the present invention can contain any conventional filler and combinations of fillers and/or other additives as are known to those skilled in the art. The fillers can include cellulosic powders and/or fibers, biomaterials including powders and fibers, and the like.

[0029] The dryer 20 in Figure 2 can be at least one of a dewatering device, filtration device, vibratory dewatering device, fluidized bed, tumble dryer, centrifuge, dryer, centrifugal dryer, and is preferably a self-cleaning centrifugal dryer. However, any separating apparatus for separating the liquid from the pellets in the liquid and pellet slurry can be used in the present invention. Post-processing can include but is not limited to at least one of cooling, enhanced crystallization, heating, additional drying, sizing, solid state polycondensation or solid state polymerization, packaging, and the like as is well known to those skilled in the art.

[0030] One embodiment of the positionable nozzle assembly 100 according to the present invention is shown in more detail in the enlarged view of Figure 2a. The assembly includes a valve 104, a pipe 106, a check valve 108, and a nozzle tube 110 which is partially inserted into elbow 102 and not visible, as indicated by the dotted line. The nozzle tube 110 is inserted into elbow 102 at insertion point 112 and extends into the lumen of elbow 102 to the juncture 114 of elbow 102 and effluent pipe 116. Inlet gas line, not shown, is attached to valve 104, which is preferably a ball valve.

[0031] The pellet slurry passing through sight glass 16 (see Figure 2) passes through influent pipe 118 and into and through elbow 102, where it interacts with the pressurized gas, preferably air, before passing into effluent pipe 116 and through valve 120. Influent pipe 118, elbow 102, and effluent pipe 116 can be a single piece of pipe that has been modified by bending to shape the elbow and to allow insertion of nozzle tube 110. Preferably, however, the influent pipe 118, elbow 102, and effluent pipe 116 are separate components that are attached together, such as by threaded engagement or welding. Influent pipe 118 and effluent pipe 116 can be the same diameter as elbow 102, or they can be of different diameter than the elbow 102 in which case they are preferably tapered to the diameter of elbow 102. According to a preferred embodiment, influent pipe 118 and elbow 102 are the same diameter and effluent pipe 116 taperingly decreases

in diameter from the juncture 114 with elbow 102 to the attachment with pipe extension 123 leading to and connecting with valve 120. Valve 120 is connected, preferably by threaded engagement or by welding, to transport pipe 18.

[0032] Optionally, effluent pipe 116 and pipe extension 123 can be disconnectedly attached by a quick disconnect connection 124 as illustrated in Figure 2a. The quick disconnect connection 124 can be any suitable pipe quick-disconnect assembly. Such a connection facilitates ease of access to the elbow and nozzle assembly for inspection, cleaning, maintenance, and repair as needed.

[0033] Influent pipe 118, elbow 102, effluent pipe 116, and nozzle tube 110 are preferably made of metal including tool steel, vanadium steel, carbon steel, hardened steel, stainless steel, nickel steel, and the like, but can also be made of wear resistant industrial grade plastic. These components are more preferably made of stainless steel and most preferably made of low carbon stainless steel.

[0034] Check valve 108 is preferably placed between a receiver tank (not shown) and the elbow 102 and prevents water and pellets from backing up into the receiver tank. Check valve 108 allows pressurized air or other gas to flow through it, but when air or other gas is not passing through it, pressure from the transport liquid will cause check valve 108 to shut, thus preventing a back flow of transport liquid and pellets. Alternatively, an automated valve, preferably an electromechanical valve with an actuator, can be substituted for check valve 108.

[0035] Valve 104 allows the operator to control the flow rate of the pressurized air or other gas. Preferably a ball valve, valve 104 is attached, such as by bolting, welding, or threaded attachment, to nozzle tube 110. Valve 104 is most preferably attached sequentially to pipe 106, check valve 108, and nozzle tube 110. Optionally and alternatively, an electromechanical valve can be substituted for both valve 104 and check valve 108.

[0036] Valve 120 can further regulate the velocity of the pressurized air or other gas. Valve 104 can be closed to allow conventional pelletization processing without the need for pressurized gas injection. Both valve 104 and valve 120 are optional and either can be used alone without the other. Preferably, valve 104 is present for regulation of the pressurized gas and more preferably, valve 104 and valve 120 are used in synergistic combination for the greatest control and regulation of the pressurized air or other gas.

[0037] The positionable nozzle assembly is preferably located as shown in Figure 2 and detailed in Figures 2a, 3, 4, and 5. A transport conduit as embodied in a transport pipe 18, see Figure 2, is preferably straight with the air or other gas being injected into elbow 102. Figures 2a, 3, and 4, are preferably in line with the axis of transport pipe 18 to maximize the effect of the injection on the pellet slurry and to uniformly aspirate the pellet slurry. The location of elbow 102, or equivalent structure such as a

"Y" configuration, is preferably in the first elbow after the pellet slurry leaves pelletizer 10. However, the elbow 102 can be located in an optional elbow further from pelletizer 10, not shown, and prior to dryer 20. Optionally a multiplicity of nozzle tubes can be inserted in at least one elbow to synergistically facilitate transport to and through at least one transport pipe 18.

[0038] Figure 3 illustrates a portion of the positionable nozzle assembly 100 in a fully retracted position relative to the elbow 102. As shown, the rearward end of the nozzle tube 110 is surrounded by collar 122 which guides the rearward end as the nozzle tube slides within cylindrical housing 128. The nozzle tube 110 and collar 122 can be of a single body construction, but preferably the nozzle tube 110 and collar 122 are separate components attached together, such as by welding. The nozzle tube 110 and collar 122 are preferably welded at each end of the collar, at weldment 124 and weldment 126.

[0039] The nozzle tube 110 and collar 122 are variably positionable and are freely slideable through the housing 128. The forward end 130 of the housing 128 is threadingly attached to a seal transition collar 132 which is attached to elbow 102 at juncture 112. The forward end of the nozzle tube 110 is slidingly supported within the central bore 133 of the collar 132. Within the housing 128 and circumferentially positioned about the nozzle tube 110 is a tension spring 134. At least one guide pin 136 is attached to the collar 122. The guide pin 136 aligns with and is positionable within at least one groove 138 in housing 128 as detailed in Figure 5. For larger transport pipes and nozzle assemblies, it is preferable to have at least two guide pins 136 that align positionably within at least two respective grooves 138 in the housing 128 to provide greater adjustment capability. Groove 138 is linearly elongate with the length of housing 128 and forms at least one angular recess 140 as shown in Figure 3, or multiple recesses 140, 141 as shown in Figure 5.

[0040] Returning to Figure 3, tension spring 134, preferably a coiled spring, seats on the forward face of collar 122 as well as on the rearward face of the seal transition collar 132. In Figure 3, the tension spring 134 is expanded for the retracted position of the nozzle tube assembly. Figure 4 shows the tension spring 134 compressed in the forwardmost position of the positionable nozzle assembly 100 in which the nozzle tube 110 is fully inserted into the lumen of elbow 102. As shown, when fully inserted the collar 122 is received in the housing 128, and guide pin 136 is locked in angular recess 140 as more clearly illustrated in Figure 5. When the nozzle tube is only partially inserted, on the other hand, the guide pin 136 would be locked in angular recess 141.

[0041] Nozzle tube 110 preferably is sealingly positioned in seal transition collar 132, Figures 3 and 4. Sealing is achieved by any mechanical means known to those skilled in the art including O-rings, "quad" rings, mechanical seals, and the like without being limited thereto. Preferably sealing is achieved using at least one O-ring 142 retained in a circumferential groove 144 in seal transition

collar 132. O-ring 142 fits sealingly about the diameter of nozzle tube 110 such that nozzle tube 110 can be sealingly and slidably positioned through the at least one O-ring 142. Preferably at least two O-rings 142 are sealingly positioned in at least two respective circumferential grooves 144. Most preferably, a multiplicity of O-rings 142 are sealingly positioned in an equal multiplicity of circumferential grooves 144.

[0042] Figure 5 illustrates a portion of the positionable nozzle assembly 100 in which the nozzle tube 110 is fully inserted into the lumen of elbow 102 approximately flush with juncture 114 as comparably illustrated and described above for Figure 2a. Collar 122 has been inserted into housing 128 and guide pin 136 has moved through groove 138 to be firmly positioned in angular recess 140.

[0043] Nozzle tube 110 can be generally positionable throughout a range from outside the exterior of elbow 102 within the lumen of seal transition collar 132 to at least the juncture 114 and optionally beyond. Preferably the fully retracted position is approximately flush with the exterior of elbow 102 and the fully inserted position is approximately at the juncture 114.

[0044] Movement of the nozzle tube 110 within the positionable nozzle assembly 100 can be accomplished by any suitable method including manual or, preferably, through the use of one or more automated control systems including pneumatic, electrical, electronic, and hydraulic devices and methods, alone or in various combinations, and can optionally include programmable logic control, PLC. It is also possible to combine manual and automated control capabilities within the same nozzle assembly. Manual control necessitates specific placement of the positioning as determined by the angular recess 140 positions. If movement is automated, however, a multiplicity of positions can be made available. Use of guide pin(s) 136 and the associated groove(s) 138 and angular recesses 140 and 141 in Figure 5, for example, would not be expected to be necessary for control using an automated control system.

[0045] A preferred embodiment of a positionable nozzle according to the present invention with an automated control system for positioning of the nozzle is shown in Figures 6a-6d. In this embodiment, the nozzle is moved to the desired position pneumatically using a pneumatic cylinder controlled by the user. The pneumatic cylinder is preferably a magnetically coupled rodless cylinder, generally designated by reference numeral 154, which magnetically engages a carriage 160 that is fixedly connected to the nozzle tube 110 and collar 122 by a bracket or pin 162. As shown, in Figures 6a and 6c the pin 162 is preferably connected between the carriage 160 and collar 122, which in turn is welded onto nozzle tube 110. However, the pin 162 could be connected directly to the nozzle tube 110. The pin 162 can be connected to the carriage 160 and collar 122/nozzle tube 110 by any suitable connection method as would be known by persons of skill in the art, but is preferably bolted to the carriage 160 and collar 122. The pin 162 passes through the hous-

ing 129 which surrounds the nozzle tube 110 and collar 122 by means of slot 139 in the housing 129 as shown in Figures 6b and 6d.

[0046] One such magnetically coupled rodless cylinder useful in the present invention is manufactured by SMC Corporation of America under Series CY1B. As shown in Figure 7, the rodless cylinder 154 includes a cylinder tube 170 having a piston 172 therein that is equipped with a first magnet 174. A second magnet 175 is supported in a body 176 of the carriage 160 outside the cylinder tube 170.

[0047] A control circuit for moving the nozzle tube 110 using the pneumatic cylinder is outlined in Figure 8 and generally designated by reference numeral 190. With reference to the nozzle tip 155, the pneumatic cylinder 154 has a first air inlet 156 at its distal end 157 and a second air inlet 158 at its proximal end 159. To move the nozzle tube 110 to the fully inserted forward position shown in Figures 6c and 6d, a jog-in mechanism such as push button 180 is activated, which changes the position of an air operated block valve 181, to inject pressurized air into the first air inlet 156. The air also is injected into a check valve 184 at the second air inlet 158 at the proximal end 159 which opens the check valve 184 and releases the pressurized air that was already in the proximal or forward end of cylinder 154, thus causing the piston 172, along with the carriage 160 that is magnetically engaged therewith, to move forwardly, with pin 162 moving in the slot 139 to the position shown in Figure 6d.

[0048] Conversely, to move the nozzle tube 110 from the inserted position to a retracted position as shown in Figures 6a and 6b, a jog-out mechanism such as push button 182 is activated, which changes the position of an air operated block valve 181, to inject pressurized air into the second air inlet 158. The air also is injected into a check valve 185 at the first air inlet 156 at the distal end 157 which opens the check valve 185 and releases the pressurized air that was already in the distal or back end of cylinder 154, thus causing the piston 172, along with the carriage 160 that is magnetically engaged therewith, to move forwardly, with pin 162 moving in the slot 139 to the position shown in Figure 6b. In between positioning events, check valve 184 and check valve 185 at the cylinder 154, as controlled by the control circuit 190, hold the nozzle tube in place by not allowing air to be released from either air inlet 156 or air inlet 158. Check valve 184 and check valve 185 also provide speed control to moderate how quickly movement of the nozzle tube is effected.

[0049] The pressurized air used to move the piston and carriage 160 can be supplied from various air sources, such as an air tank compressor as is known by persons of skill in the art. With this pneumatic embodiment, any number of intermediate positions of the nozzle tube between the fully inserted (Figures 6c and 6d) and fully retracted (Figures 6a and 6b) positions can be realized through control of the amount of pressurized air being injected into the air inlets 156, 158. Similar movement

and control of the nozzle tube could alternatively be obtained through the use of a linear pneumatic cylinder, a hydraulic cylinder and power unit, or a servo-motor or a stepper motor together with a ball screw or acme screw, instead of the magnetically coupled rodless cylinder 154, as would be known to those skilled in the art. However, the magnetically coupled rodless cylinder is preferred for the present invention.

[0050] It is also possible in accordance with the present invention that the preferred automatic control system for moving the nozzle can be combined with a manual movement of the nozzle tube, if desired.

[0051] Preferably nozzle tube 110 can be placed in a retracted position during the "start-up" of pelletizer 10 to eliminate its presence as an obstruction in the transport piping 15. Unwanted agglomerates can easily be formed during the beginning phase of the pelletization process and allowing the pellet slurry to use the full inside diameter of transport piping 15 as facilitated by the retraction of nozzle tube 110 is beneficial.

[0052] Positionable nozzle assembly 100 is designed to allow the operator(s) to inject pressurized air or other gas into transport pipe 18 while having the option to adjust the location of the nozzle tube 110 in relation to the transport pipe 18 and the elbow 102. The extent to which nozzle tube 110 can be retracted and inserted while still creating the desired aspiration is dependent upon, but not limited to, at least one of flow rate, pellet to transport liquid ratio, transport liquid temperature, diameter of the elbow 102 relative to the transport pipe 18, distance between the elbow 102 and the dryer 20, and the type of material being pelletized.

[0053] It is to be understood, as illustrated in Figures 2a, 3 and 4, that the outside diameter of nozzle tube 110 will be smaller than the inside diameter of elbow 102 at juncture 114, for example. In this regard, the space in the lumen should be large enough to allow the combined largest dimensions of at least two pellets, as measured using pellets of the maximum size for the particular pelletizing system, to pass between the exterior of the nozzle tube 110 and the interior of elbow 102 at juncture 114. Stated another way, the clearance area between the outside diameter of the nozzle tube and the inside diameter of the elbow lumen is large enough to allow at least two pellets, each having a maximum dimension for the pelletizer, to pass side by side therethrough without blocking, or clogging in, the clearance area. By way of example, without being limited thereto, one embodiment of the present invention is that of a 1.9cm (0.75 inch) nominal nozzle tube 110 in combination with a 5.1cm (2 inch) nominal nozzle influent pipe 118 to elbow 102, a 2.5cm (2 inch) nominal elbow 102, and a 3.8cm (1.5 inch) transport pipe 18 from elbow 102 to dryer 20. Another embodiment is that of a 1.9cm (0.75 inch) nominal nozzle tube 110 in combination with a 7.6cm (3.0 inch) nominal elbow 102, and a further embodiment is that of a 1.3cm (0.5 inch) nominal nozzle tube 110 in combination with a 5.1cm (2.0 inch) nominal elbow.

[0054] The orientation of the nozzle tube 110 in relation to the juncture 114 of elbow 102 in Figure 2a can be concentrically centered about the centerline of that juncture 114, or reflected above the centerline, below the centerline, to the right or left of the centerline, or at any angle circumferentially about that centerline where the angle formed between the centerline of the nozzle tube 110 and the centerline of the juncture 114 of elbow 102 can range from 0° to a maximum deflection. Maximum deflection is defined as that degree of deflection at which the exterior of nozzle tube 110 touches the interior of the juncture 114 of elbow 102 and/or any apparatus into which the nozzle tube 110 extends downstream of that juncture 114 of elbow 102. Preferably the nozzle tube 110 is concentrically positioned and collinear about that centerline of juncture 114 of elbow 102. It is understood that the centerline of juncture 114 of elbow 102 is colinear with the centerline of transport pipe 18 downstream of that juncture 114.

[0055] The forward orifice 146 of nozzle tube 110 can be of any shape including round, square, rectangular, oval, polygonal, and the like and is preferably round. The diameter of the forward orifice 146 can be larger than, smaller than, or equal to the diameter of the nozzle tube 110 and is preferably equal thereto. When the diameter of forward orifice 146 is not equal to that of the nozzle tube 110, the diameter taperingly increases or decreases, respectively, for only that portion of the nozzle tube 110 that is not in contact with the most proximate O-ring 142; see Figures 3 and 4. The diameter of the distal orifice 146 cannot, however, be larger than the inside diameter of the seal transition collar 132. A decreasing taper 150 is illustrated in Figure 9e for the terminus of nozzle tube 110. Similarly the forward orifice 146 can be semicircular as illustrated in Figure 9c or conchoidal to C-shape as in Figure 9d.

[0056] The inside of nozzle tube 110 can be provided with many different variations including but not limited to at least one of spiraled, contoured, rifled, or tapered inner surfaces, and many combinations thereof. Figure 9f illustrates a conically tapered nozzle tube 110 wherein the taper decreases toward the forward orifice 146.

[0057] The inside of nozzle tube 110 can also or alternatively contain one or more fins 152 as shown in Figures 9a and 9b. The fins can be straight and angled at 90° relative to the circumference of the nozzle tube 110, as illustrated in Figure 9a, or at a lesser angle. Similarly, the fins can be bent or contoured relative to the circumference of the nozzle tube 110 as illustrated in Figure 9b. The fins can be of any length ranging from less than to equal the length of the nozzle tube 110, and their height cannot exceed the radius of nozzle tube 110. Preferably the fins 152 are less than the length of the nozzle tube 110 and are smaller in height than the radius of nozzle tube 110. When multiple fins are included, they can also be placed at any angle in relation to each other and can be the same or different in construction. The purpose of the fins is to facilitate the creation of more turbulent flow

within the transport pipe 18. More particularly, the flow of the aspirated pellet slurry can range from laminar to turbulent. Without intending to be bound by any theory, the injection of the air or other gas into the pellet slurry aspirates the transport liquid from the pellets such that the transport liquid is transported in a laminar fashion along the inner surface of the transport pipe 18 while the vapor mist and pellets are propagated in a more turbulent flow through the center of transport pipe 18 along the length of the transport pipe 18. In some cases, more turbulent flow may be desired, in which case fins may be advantageously added.

[0058] In accordance with the present invention, pressurized air or other gas can flow through nozzle tube 110 continuously or intermittently, most preferably continuously. This pressurized gas can be used to convey the pellets at a high velocity as described. This high velocity gas flow can be achieved using compressed gas producing a volume of flow exemplarily of at least 100 cubic meters per hour using a standard valve 104 for regulation of the pressure to at least 8 bar through the transport pipe 18. The pipe 18 is standard pipe diameter, preferably 3,8cm (1.5 inch) pipe diameter. To those skilled in the art, flow rates and pipe diameters will vary according to the throughput volume, material composition including filler, transport liquid temperature, level of crystallinity desired, level of moisture desired, and the size of the pellets and granules. The high velocity gas effectively contacts the pellet water slurry, generating water vapor by aspiration, and disperses the pellets throughout the slurry line to propagate those pellets at increased velocity to the dryer 20, preferably at a rate of less than one second from the pelletizer 10 to the exit of the dryer 20. The high velocity aspiration produces a mixture of pellets in an air/gas mixture which may approach 98-99% by volume of the gaseous mixture. Through adjustment of the nozzle tube insertion depth as well as the addition of surface variations inside the nozzle, the flow characteristics of the slurry within the transport piping can be altered.

[0059] Returning now to Figure 2a, the angle formed between the vertical axis of influent pipe 118 and the longitudinal axis of the transport pipe 18 can vary from 0° to 90° or more as required by the variance in the height of the pelletizer 10 relative to the height of the entrance 22 to the dryer 20 as shown in Figure 2. This difference in height may be due to the physical positioning of the dryer 20 in relation to the pelletizer 10 or may be a consequence of the difference in the sizes of the the dryer and pelletizer. The preferred angle range is from about 30° to 60°, with the more preferred angle being about 45°. The enlarged elbow 24 into the dryer entrance 22 facilitates the transition of the high velocity aspirated pellet/water slurry from the incoming transport pipe 18 into the entrance 22 of the dryer 20 and reduces the potential for pellet agglomeration into the dryer 20.

[0060] The outside surface of nozzle tube 110 and the inner lumens of influent pipe 118, elbow 102, effluent pipe 116, and transport pipe 18 can be coated with sur-

face treatments to reduce abrasion, erosion, corrosion, wear, and undesirable adhesion and stricture. These surface treatments can be at least one of nitriding, carbonitriding, and sintering. Similarly the heretofore mentioned surfaces can undergo high velocity air and fuel modified thermal treatments, electrolytic plating, electroless plating, flame spray, thermal spray, plasma treatment, electroless nickel dispersion treatments, and electrolytic plasma treatments, singly and in combinations thereof. These treatments metallize the surface, preferably fixedly attach metal nitrides to the surface, more preferably fixedly attach metal carbides and metal carbonitrides to the surface, even more preferably fixedly attach diamond-like carbon to the surface, still more preferably attach diamond-like carbon in an abrasion-resistant metal matrix to the surface, and most preferably attach diamond-like carbon in a metal carbide matrix to the surface. Other ceramic materials can be used and are included herein by way of reference without intending to be limited. The coating thickness should not exceed approximately 0,05 mm (0.002 inches) without appropriate modification to the diameters of the parts through which the coated surface must pass sealingly.

[0061] While the invention has been disclosed in its preferred forms, it will be apparent to those skilled in the art that many modifications, additions, and deletions can be made therein without departing from the scope of the invention as set forth in the following claims.

Claims

1. An injecting device for use with an underwater pelletizer apparatus (10) including a pelletizer that extrudes and cuts polymer strands into pellets, and transport piping to transport a liquid and pellet slurry out of said pelletizer and to a separator, preferably a centrifugal dryer (20), for separating and drying said pellets,
characterized in that,
said device includes a positionable nozzle assembly (100) having a movable nozzle tube (110) within a housing (128) for introducing a pellet speed expediter into said liquid and pellet slurry to increase a velocity of the pellet slurry to and through the dryer such that more internal heat of the pellets is retained, said nozzle tube being movable between a fully inserted position and a fully retracted position.
2. The injecting device according to claim 1, wherein said transport piping of said underwater pelletizer apparatus includes an outlet pipe (14) coupled to said pelletizer through which the slurry is passed to a transport pipe (18) that conveys the slurry to the dryer, said outlet pipe and said transport pipe being joined by an angled elbow joint (102) into which said movable nozzle tube can extend so as to be in line with an axis of said transport pipe downstream of

said positionable nozzle assembly, said positionable nozzle assembly preferably including a seal transition collar (132) affixed to said angled joint, a housing attached to said seal transition collar, and a sliding collar (122) that is fixed to said nozzle tube and received within said housing, said sliding collar and said nozzle tube preferably being freely movable within said housing.

3. The injecting device according to claim 2, wherein said housing includes a tension spring (134) positioned circumferentially around the nozzle tube and seated on a forward face of the sliding collar and a rearward face of the seal transition collar, said tension spring being compressed as said movable nozzle tube is advanced with respect to said angled joint.
4. The injecting device according to claim 3, wherein said nozzle tube is manually adjustable between said fully inserted and fully retracted positions and said housing has at least one groove (138) that extends parallel with said movable nozzle tube, said groove having at least one angled recess, said sliding collar having a guide pin (136) attached thereto that is positionable within said groove and, when received in said angled recess, locks the nozzle assembly at a set degree of tension spring compression associated with a particular insertion position, said pellet speed expediter preferably being pressurized gas and said nozzle assembly preferably including at least one valve (104, 120) configured to control the flow of said pressurized gas.
5. The injecting device according to claim 1, wherein said positionable nozzle assembly includes an automated control system configured to automatically effect movement of said nozzle tube between said fully inserted and fully retracted positions, and to position said nozzle tube at any position therebetween.
6. The injecting device according to claim 5, wherein said automated control system includes a magnetically coupled rodless pneumatic cylinder (154), a linear pneumatic cylinder, a hydraulic cylinder and power unit, or a servo-motor or a stepper motor together with a ball screw or acme screw, preferably a pneumatic cylinder (154) mounted to said housing and configured to move said nozzle tube between first and second ends of said cylinder in response to injection of pressurized air into said cylinder.
7. The injecting device according to claim 6, wherein said positionable nozzle assembly further includes a sliding collar (122) that is fixed to said nozzle tube (110) and received within said housing, and a carriage (160) that is movably engaged with said pneumatic cylinder (154), said pneumatic cylinder containing a piston (172) that is magnetically engaged

with said carriage such that movement of said piston by injection of said pressurized air also moves said carriage and said nozzle tube, preferably said carriage (160) being coupled to said sliding collar (122) by a pin (162) that passes through a slot in the housing.

8. The injecting device according to claim 1, wherein a geometric configuration of said nozzle tube is one of round, square, rectangular, oval, polygonal, semicircular, conchoidal or C-shaped, or said nozzle tube preferably being tapered at an effluent end or said nozzle tube preferably having an inner surface that is spiraled, contoured, rifled, tapered or some combination thereof, or said nozzle tube preferably being coated with a coating to resist erosion, abrasion and corrosion.
9. A method for processing extrudable materials into pellets using the injecting device of claim 1, which includes extruding an extrudable material into strands and cutting the extruded strands into pellets in a liquid using an underwater pelletizer, and transporting said pellets and said liquid as a liquid and pellet slurry through a transport conduit to a separator,
characterized in that said method includes, adjusting a positionable pressurized gas nozzle assembly to a desired degree of insertion within said transport conduit;
injecting a pressurized gas into said transport conduit at a high velocity using said gas nozzle assembly to facilitate separation of the liquid from the pellets as the slurry moves through the transport conduit; and
separating said pellets from said liquid.
10. The method of claim 9, wherein said gas nozzle assembly includes a gas nozzle fitted within a sliding collar having a guide pin thereon, said step of adjusting being performed manually and said step of injecting further including sliding said gas nozzle into a housing mounted on said transport pipe, said housing having at least one groove and an angled recess to receive said guide pin in a fixed position when said nozzle is at the desired degree of insertion.
11. The method of claim 9, wherein said step of adjusting includes automatically moving a gas nozzle of said gas nozzle assembly to the desired degree of insertion under control of an automated control system, preferably said step of automatically moving a gas nozzle being performed using a magnetically coupled rodless pneumatic cylinder, a linear pneumatic cylinder, a hydraulic cylinder and power unit, or a servo-motor or a stepper motor together with a ball screw or acme screw.

12. The method of claim 9, wherein said gas nozzle assembly includes an automated control system with a pneumatic cylinder configured to automatically effect movement of said nozzle tube between fully inserted and fully retracted positions, said method including the steps of injecting pressurized air into one end of said cylinder to move the nozzle tube to said fully inserted position, and injecting pressurized air into an opposite end of said cylinder to move the nozzle tube to said fully retracted position, and preferably further including the steps of fixedly coupling said gas nozzle to a carriage and magnetically coupling said carriage to a piston within said cylinder so that said step of injecting pressurized air moves said piston and, through said magnetic coupling, also moves said carriage and gas nozzle.

13. The method of claim 9, wherein the extrudable material is a crystallizable polymeric material having sufficient heat for crystallization and said injecting step causes said polymeric material to retain sufficient heat to initiate self-crystallization to a level of at least 20%.

14. The method of claim 9 wherein said injecting step enhances the separating of the pellets from the liquid and/or the drying of the pellets during the step of separating the pellets from the liquid.

Patentansprüche

1. Einspritzvorrichtung zur Verwendung mit einer Unterwassergranulatoreinrichtung (10), die einen Granulator, der Polymerstränge extrudiert und zu Granulat schneidet, und Transportrohre zum Transportieren eines Flüssigkeits- und Granulatschlammes aus dem Granulator heraus und zu einem Separator, vorzugsweise einem Zentrifugaltrockner (20), zum Trennen und Trocknen des Granulats umfasst,
dadurch gekennzeichnet ist, dass,
die Vorrichtung eine positionierbare Düsenbaugruppe (100) mit einem beweglichen Düsenrohr (110) in einem Gehäuse (128) zum Einleiten eines Granulatgeschwindigkeitsbeschleunigers in den Flüssigkeits- und Granulatschlamm umfasst, um eine Geschwindigkeit des Granulatschlammes zu und durch den Trockner zu steigern, so dass mehr Innenwärme des Granulats beibehalten wird, wobei das Düsenrohr zwischen einer vollständig eingeführten Stellung und einer zurückgezogenen Stellung bewegbar ist.
2. Einspritzvorrichtung nach Anspruch 1, wobei die Transportrohre der Unterwassergranulatoreinrichtung ein mit dem Granulator gekoppeltes Auslassrohr (14) umfassen, durch das der Schlamm zu einem Transportrohr (18) geleitet wird, das den

- Schlamm zu dem Trockner befördert, wobei das Auslassrohr und das Transportrohr durch eine abgewinkelte Eckverbindung (102) verbunden sind, in die sich das bewegliche Düsenrohr erstrecken kann, um mit einer Achse des Transportrohrs stromabwärts der positionierbaren Düsenbaugruppe in einer Linie zu sein, wobei die positionierbare Düsenbaugruppe bevorzugt einen Dichtungsübergangskragen (132), der an der abgewinkelten Verbindung befestigt ist, ein Gehäuse, das an dem Dichtungsübergangskragen angebracht ist, und einen Gleitkragen (122), der an dem Düsenrohr fixiert und in dem Gehäuse aufgenommen ist, umfasst, wobei der Gleitkragen und das Düsenrohr in dem Gehäuse bevorzugt frei beweglich sind.
3. Einspritzvorrichtung nach Anspruch 2, wobei das Gehäuse eine Zugfeder (134) umfasst, die umlaufend um das Düsenrohr positioniert ist und auf einer vorderen Fläche des Gleitkragens und einer hinteren Fläche des Dichtungsübergangskragens sitzt, wobei die Zugfeder zusammengedrückt wird, wenn das bewegliche Düsenrohr bezüglich der abgewinkelten Verbindung vorbewegt wird.
4. Einspritzvorrichtung nach Anspruch 3, wobei das Düsenrohr zwischen der vollständig eingeführten und der vollständig zurückgezogenen Stellung manuell verstellbar ist und das Gehäuse mindestens eine Nut (138) aufweist, die sich parallel zu dem beweglichen Düsenrohr erstreckt, wobei die Nut mindestens eine abgewinkelte Aussparung umfasst, wobei der Gleitkragen einen daran angebrachten Führungsstift (136) aufweist, der in der Nut positionierbar ist und bei Aufnahme in der abgewinkelten Aussparung die Düsenbaugruppe bei einem festgelegten Grad an Zugfederkompression in Verbindung mit einer bestimmten Einführstellung arretiert, wobei der Granulatgeschwindigkeitsbeschleuniger vorzugsweise Druckgas ist und die Düsenbaugruppe vorzugsweise mindestens ein Ventil (104, 120) umfasst, das ausgelegt ist, um die Strömung des Druckgases zu steuern.
5. Einspritzvorrichtung nach Anspruch 1, wobei die positionierbare Düsenbaugruppe ein automatisiertes Steuersystem umfasst, das ausgelegt ist, um eine Bewegung des Düsenrohrs zwischen der vollständig eingeführten und der vollständig zurückgezogenen Stellung automatisch zu bewirken und um das Düsenrohr an einer beliebigen Stellung dazwischen zu positionieren.
6. Einspritzvorrichtung nach Anspruch 5, wobei das automatisierte Steuersystem einen magnetisch gekoppelten stangenlosen Pneumatikzylinder (154), einen linearen Pneumatikzylinder, einen Hydraulikzylinder und einen Antrieb oder einen Servomotor oder einen Schrittmotor zusammen mit einem Kugelgewinde oder Trapezgewinde, vorzugsweise einen Pneumatikzylinder (154), der an dem Gehäuse montiert und ausgelegt ist, um das Düsenrohr zwischen dem ersten und zweiten Ende des Zylinders als Reaktion auf das Einspritzen von Druckluft in den Zylinder zu bewegen, umfasst.
7. Einspritzvorrichtung nach Anspruch 6, wobei die positionierbare Düsenbaugruppe weiterhin einen Gleitkragen (122), der an dem Düsenrohr (110) fixiert und in dem Gehäuse aufgenommen ist, und einen Schlitten (160), der mit dem Pneumatikzylinder (154) beweglich in Eingriff steht, umfasst, wobei der Pneumatikzylinder einen Kolben (172) enthält, der mit dem Schlitten magnetisch in Eingriff steht, so dass die Bewegung des Kolbens durch Einspritzen der Druckluft auch den Schlitten und das Düsenrohr bewegt, wobei der Schlitten (160) vorzugsweise durch einen Stift (162), der durch einen Schlitz in dem Gehäuse tritt, mit dem Gleitkragen (122) gekoppelt ist.
8. Einspritzvorrichtung nach Anspruch 1, wobei eine geometrische Konfiguration des Düsenrohrs entweder rund, quadratisch, rechteckig, oval, polygonal, halbkreisförmig, muschelförmig oder C-förmig ist, oder wobei das Düsenrohr vorzugsweise an einem Ausflussende konisch ist oder das Düsenrohr vorzugsweise eine Innenfläche aufweist, die spiralförmig, konturiert, geriffelt, konisch oder eine Kombination derselben ist, oder wobei das Düsenrohr vorzugsweise mit einer Beschichtung beschichtet ist, um Erosion, Abrieb und Korrosion standzuhalten.
9. Verfahren zum Verarbeiten von extrudierbaren Materialien zu Granulat unter Verwenden der Einspritzvorrichtung von Anspruch 1, welches das Extrudieren eines extrudierbaren Materials zu Strängen und das Schneiden der extrudierten Stränge in einer Flüssigkeit unter Verwenden eines Unterwassergranulators zu Granulat und das Transportieren des Granulats und der Flüssigkeit als Flüssigkeits- und Granulatschlamm durch eine Transportleitung zu einem Separator umfasst, **dadurch gekennzeichnet, dass** das Verfahren umfasst:
- Verstellen einer positionierbaren Druckgasdüsenbaugruppe zu einem erwünschten Einführgrad in der Transportleitung;
Einspritzen eines Druckgases in die Transportleitung unter Verwenden der Gasdüsenbaugruppe bei einer hohen Geschwindigkeit, um ein Trennen der Flüssigkeit von dem Granulat zu erleichtern, wenn sich der Schlamm durch die Transportleitung bewegt; und
Trennen des Granulats von der Flüssigkeit.

10. Verfahren nach Anspruch 9, wobei die Gasdüsenbaugruppe eine Gasdüse umfasst, die in einen Gleitkragen mit einem Führungsstift daran eingesetzt ist, wobei der Schritt des Verstellens manuell durchgeführt wird und der Schritt des Einspritzens weiterhin das Schieben der Gasdüse in ein an dem Transportrohr montiertes Gehäuse umfasst, wobei das Gehäuse mindestens eine Nut und eine abgewinkelte Aussparung umfasst, um den Führungsstift in einer festen Position aufzunehmen, wenn sich die Düse bei dem erwünschten Einführgrad befindet. 5 10
11. Verfahren nach Anspruch 9, wobei der Schritt des Verstellens das automatische Bewegen einer Gasdüse der Gasdüsenbaugruppe auf einen erwünschten Einführgrad unter der Steuerung eines automatisierten Steuersystems umfasst, wobei der Schritt des automatischen Bewegens einer Gasdüse vorzugsweise unter Verwenden eines magnetisch gekoppelten stangenlosen Pneumatikzylinders, eines linearen Pneumatikzylinders, eines Hydraulikzylinders und eines Antriebs oder eines Servomotors oder eines Schrittmotors zusammen mit einem Kugelgewinde oder Trapezgewindet durchgeführt wird. 15 20
12. Verfahren nach Anspruch 9, wobei die Gasdüsenbaugruppe ein automatisiertes Steuersystem mit einem Pneumatikzylinder umfasst, der ausgelegt ist, um automatisch eine Bewegung des Düsenrohrs zwischen der vollständig eingeführten und der vollständig zurückgezogenen, Stellung zu bewirken, wobei das Verfahren die Schritte des Einspritzens von Druckluft in ein Ende des Zylinders, um das Düsenrohr zu der vollständig eingeführten Stellung zu bewegen, und des Einspritzens von Druckluft in ein gegenüberliegendes Ende des Zylinders, um das Düsenrohr zu der vollständig zurückgezogenen Stellung zu bewegen, umfasst und ferner bevorzugt die Schritte des festen Koppels der Gasdüse mit einem Schlitten und des magnetischen Koppels des Schlittens mit einem Kolben in dem Zylinder umfasst, so dass der Schritt des Einspritzens von Druckluft den Kolben bewegt und durch das magnetische Koppeln auch den Schlitten und die Gasdüse bewegt. 30 35 40 45
13. Verfahren nach Anspruch 9, wobei das extrudierbare Material ein kristallisierbares Polymermaterial ist, das ausreichend Wärme für Kristallisierung aufweist, und der Einspritzschritt das Polymermaterial ausreichend Wärme beibehalten lässt, um eine Selbstkristallisierung bei einem Wert von mindestens 20% auszulösen. 50
14. Verfahren nach Anspruch 9, wobei der Einspritzschritt das Trennen des Granulats von der Flüssigkeit und/oder das Trocknen des Granulats während des Schritts des Trennens des Granulats von der Flüssigkeit verbessert. 55

Revendications

1. Dispositif d'injection pour l'utilisation avec un appareil de pastillage immergé (10) comportant une pastilleuse qui extrude et coupe en pastilles des brins de polymère, et une tuyauterie de transport pour transporter une bouillie de liquide et de pastilles hors de ladite pastilleuse et vers un séparateur, de préférence un séchoir centrifuge (20), pour séparer et sécher lesdites pastilles, **caractérisé en ce que** ledit dispositif comporte un ensemble de buse (100) pouvant être positionné présentant un tube de buse mobile (110) dans un boîtier (128) pour introduire un accélérateur de vitesse de pastille dans ladite bouillie de liquide et de pastilles pour augmenter une vitesse de la bouillie de pastilles vers et à travers le séchoir de sorte qu'une plus grande quantité de chaleur intérieure des pastilles est gardée, ledit tube de buse étant mobile entre une position complètement insérée et une position complètement rétractée. 5 10
2. Dispositif d'injection selon la revendication 1, dans lequel ladite tuyauterie de transport dudit appareil de pastillage immergé comporte un tuyau de sortie (14) couplé à ladite pastilleuse à travers lequel la bouillie est transférée dans un tuyau de transport (19) qui transporte la bouillie vers le séchoir, ledit tuyau de sortie et ledit tuyau de transport étant assemblés par un raccord coudé angulaire (102) dans lequel ledit tube de buse mobile peut s'étendre de façon à être aligné avec un axe dudit tuyau de transport en aval dudit ensemble de buse pouvant être positionné, ledit ensemble de buse pouvant être positionné comportant de préférence un collier de transition d'étanchéité (132) fixé sur ledit raccord angulaire, un boîtier attaché audit collier de transition d'étanchéité, et un collier coulissant (122) qui est fixé sur ledit tube de buse et logé dans ledit boîtier, ledit collier coulissant et ledit tube de buse étant de préférence librement mobiles dans ledit boîtier. 25 30 35 40 45
3. Dispositif d'injection selon la revendication 2, dans lequel ledit boîtier comporte un ressort de traction (134) positionné de manière circonférentielle autour du tube de buse et calé sur une face avant du collier coulissant et une face arrière du collier de transition d'étanchéité, ledit ressort de traction étant comprimé lorsque ledit tube de buse mobile est avancé par rapport audit raccord angulaire. 50
4. Dispositif d'injection selon la revendication 3, dans lequel ledit tube de buse est réglable manuellement entre lesdites positions complètement insérée et complètement rétractée et ledit boîtier présente au moins une rainure (138) qui s'étend parallèlement audit tube de buse mobile, ladite rainure présentant au moins un évidement angulaire, ledit collier cou- 55

- lissant présentant une tige de guidage (136) attachée à celui-ci qui peut être positionnée dans ladite rainure et, quand elle est logée dans ledit évidement angulaire, bloque l'ensemble de buse à un degré réglé de compression de ressort de traction associé à une position d'insertion particulière, ledit accélérateur de vitesse de pastille étant de préférence du gaz sous pression et ledit ensemble de buse comportant de préférence au moins une valve (104, 120) configurée pour commander le débit dudit gaz sous pression.
5. Dispositif d'injection selon la revendication 1, dans lequel ledit ensemble de buse pouvant être positionné comporte un système de commande automatisé configuré pour entraîner automatiquement un mouvement dudit tube de buse entre lesdites positions complètement insérée et complètement rétractée, et pour positionner ledit tube de buse à une quelconque position entre celles-ci.
 6. Dispositif d'injection selon la revendication 5, dans lequel ledit système de commande automatisé comporte un vérin pneumatique sans tige (154) couplé magnétiquement, un vérin pneumatique linéaire, un vérin et un groupe hydrauliques, ou un servomoteur ou un moteur pas-à-pas avec une vis à billes ou une vis à filetage trapézoïdal, de préférence un vérin pneumatique (154) monté sur ledit boîtier et configuré pour déplacer ledit tube de buse entre une première et une seconde extrémité dudit vérin en réaction à l'injection d'air sous pression dans ledit vérin.
 7. Dispositif d'injection selon la revendication 6, dans lequel ledit ensemble de buse pouvant être positionné comporte en outre un collier coulissant (122) qui est fixé sur ledit tube de buse (110) et logé dans ledit boîtier, et un chariot (160) qui est en prise mobile avec ledit vérin pneumatique (154), ledit vérin pneumatique contenant un piston (172) qui est en prise magnétique avec ledit chariot de sorte qu'un mouvement dudit piston par l'injection dudit air sous pression déplace également ledit chariot et ledit tube de buse, ledit chariot (160) étant de préférence couplé audit collier coulissant (122) par une tige (162) qui passe à travers une encoche dans le boîtier.
 8. Dispositif d'injection selon la revendication 1, dans lequel une configuration géométrique dudit tube de buse est de forme ronde, carrée, rectangulaire, ovale, polygonale, semi-circulaire, conchoïdale ou en forme de C, ou ledit tube de buse étant de préférence à section décroissante à une extrémité effluente ou ledit tube de buse présentant de préférence une surface intérieure qui est en spirale, profilée, rainurée, à section décroissante ou une combinaison de celles-ci, ou ledit tube de buse étant de préférence revêtu d'un revêtement pour résister à l'érosion, l'abrasion et la corrosion.
 9. Procédé pour le traitement de matières extrudables pour obtenir des pastilles utilisant le dispositif d'injection selon la revendication 1, qui comporte l'extrusion d'une matière extrudable en des brins et la découpe des brins extrudés en pastilles dans un liquide en utilisant une pastilleuse immergée, et le transport desdites pastilles et dudit liquide sous forme de bouillie de liquide et de pastilles à travers une conduite de transport vers un séparateur, **caractérisé en ce que** ledit procédé comprend le réglage d'un ensemble de buse à gaz sous pression pouvant être positionné à un degré d'insertion dans ladite conduite de transport ; l'injection d'un gaz sous pression à haute vitesse dans ladite conduite de transport en utilisant ledit ensemble de buse à gaz pour faciliter la séparation du liquide et des pastilles lorsque la bouillie se déplace à travers la conduite de transport ; et la séparation desdites pastilles et dudit liquide.
 10. Procédé selon la revendication 9, dans lequel ledit ensemble de buse à gaz comporte une buse à gaz ajustée dans un collier coulissant présentant une tige de guidage sur lui, ladite étape de réglage étant effectuée manuellement et ladite étape d'injection comportant en outre le glissement de ladite buse à gaz dans un boîtier monté sur ledit tuyau de transport, ledit boîtier présentant au moins une rainure et un évidement angulaire pour loger ladite tige de guidage dans une position fixe quand ladite buse est au degré d'insertion souhaité.
 11. Procédé selon la revendication 9, dans lequel ladite étape de réglage comporte le déplacement automatique d'une buse à gaz dudit ensemble de buse à gaz au degré d'insertion souhaité sous la commande d'un système de commande automatisé, ladite étape de déplacement automatique d'une buse à gaz étant de préférence effectuée en utilisant un vérin pneumatique sans tige couplé magnétiquement, un vérin pneumatique linéaire, un vérin et un groupe hydrauliques, ou un servomoteur ou un moteur pas-à-pas avec une vis à billes ou une vis à filetage trapézoïdal.
 12. Procédé selon la revendication 9, dans lequel ledit ensemble de buse à gaz comporte un système de commande automatisé avec un vérin pneumatique configuré pour entraîner automatiquement un mouvement dudit tube de buse entre des positions complètement insérée et complètement rétractée, ledit procédé comportant les étapes d'injection d'air sous pression dans une extrémité dudit vérin pour déplacer le tube de buse dans ladite position complètement insérée, et l'injection d'air sous pression dans une extrémité opposée dudit vérin pour déplacer le

tube de buse dans ladite position complètement rétractée, et comportant de préférence en outre les étapes de couplage fixe de ladite buse à gaz à un chariot et de couplage magnétique dudit chariot à un piston dans ledit vérin de sorte que ladite étape d'injection d'air sous pression déplace ledit piston et, par ledit couplage magnétique, déplace également ledit chariot et ladite buse à gaz.

13. Procédé selon la revendication 9, dans lequel la matière extrudable est une matière polymérique cristallisable présentant une chaleur suffisante pour la cristallisation et ladite étape d'injection permet que ladite matière polymérique garde suffisamment de chaleur pour commencer une auto-cristallisation à un niveau d'au moins 20 %.
14. Procédé selon la revendication 9, dans lequel ladite étape d'injection améliore la séparation des pastilles et du liquide et/ou le séchage des pastilles pendant l'étape de séparation des pastilles et du liquide.

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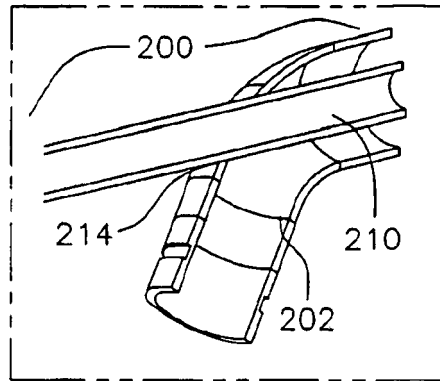


FIG. 1
PRIOR ART

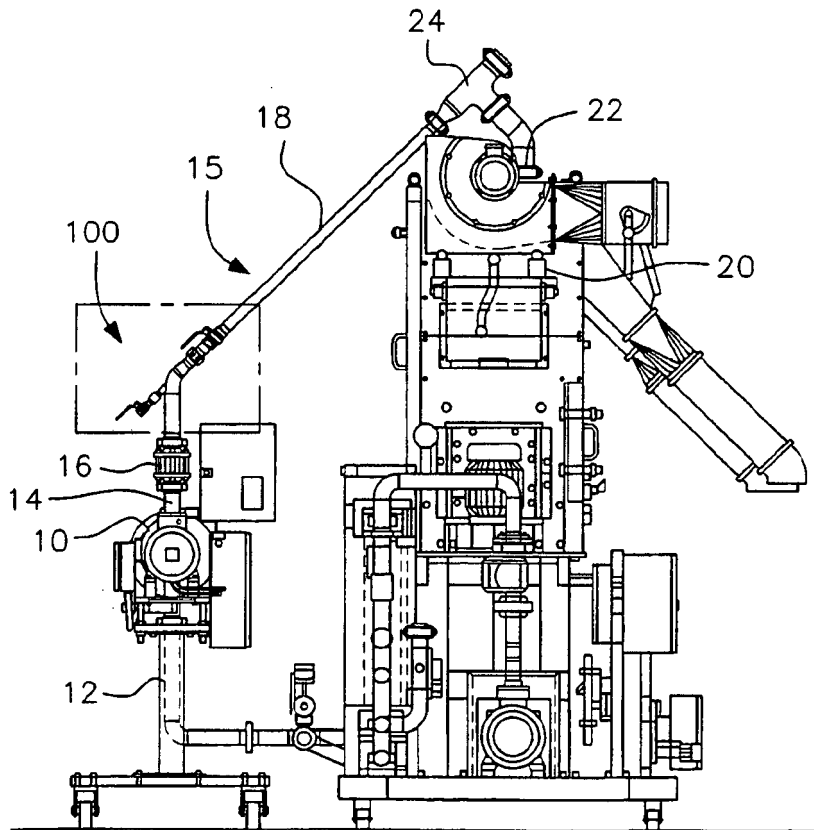


FIG. 2

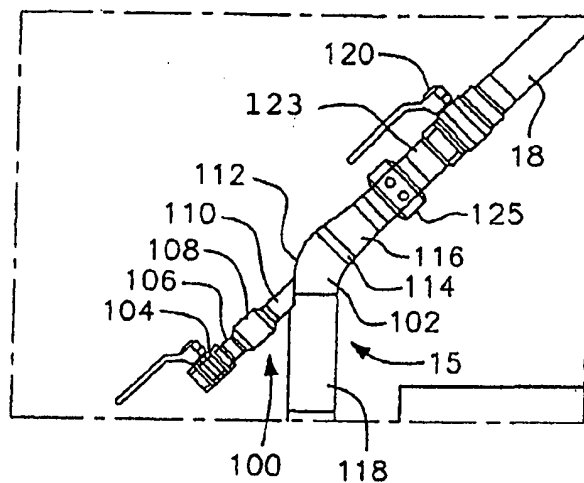


FIG. 2a

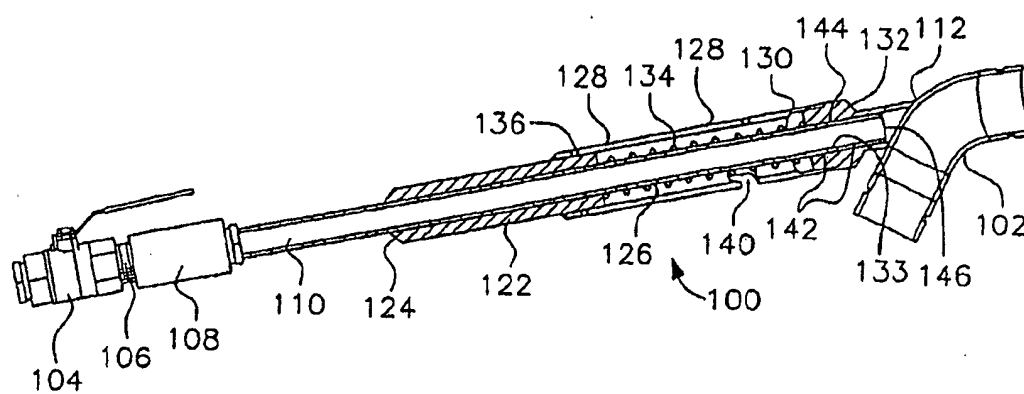


FIG. 3

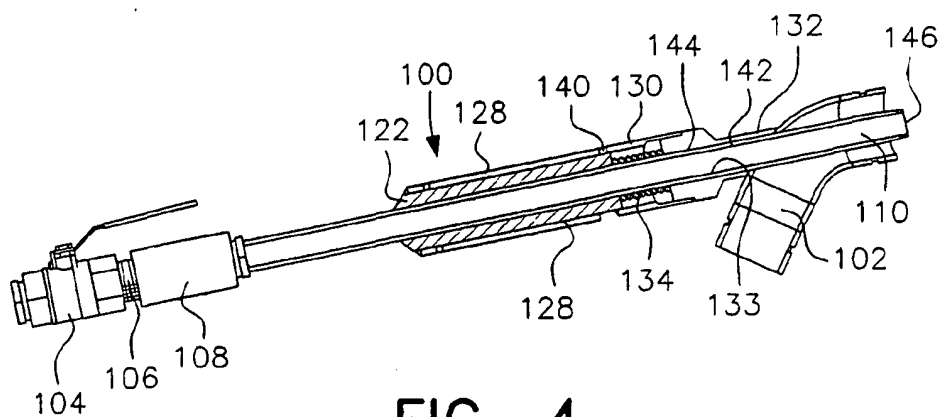


FIG. 4

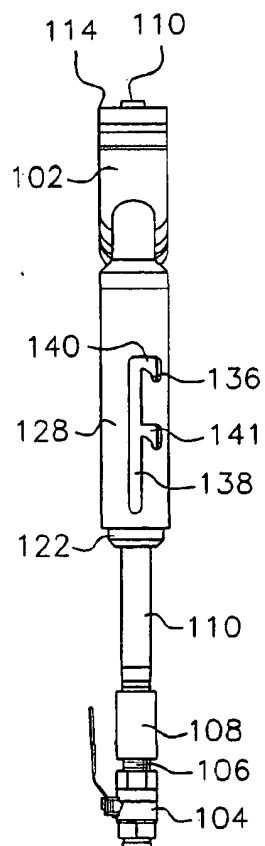


FIG. 5

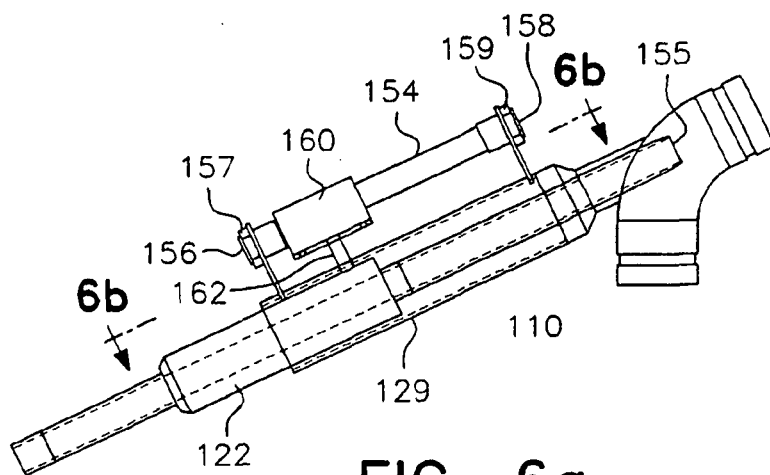


FIG. 6a

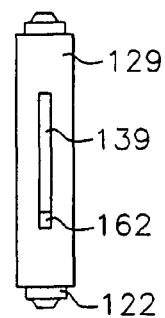


FIG. 6b

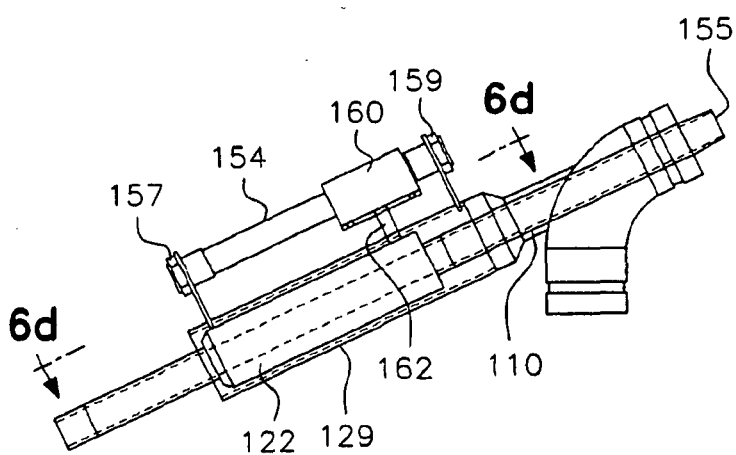


FIG. 6c

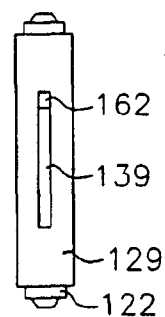
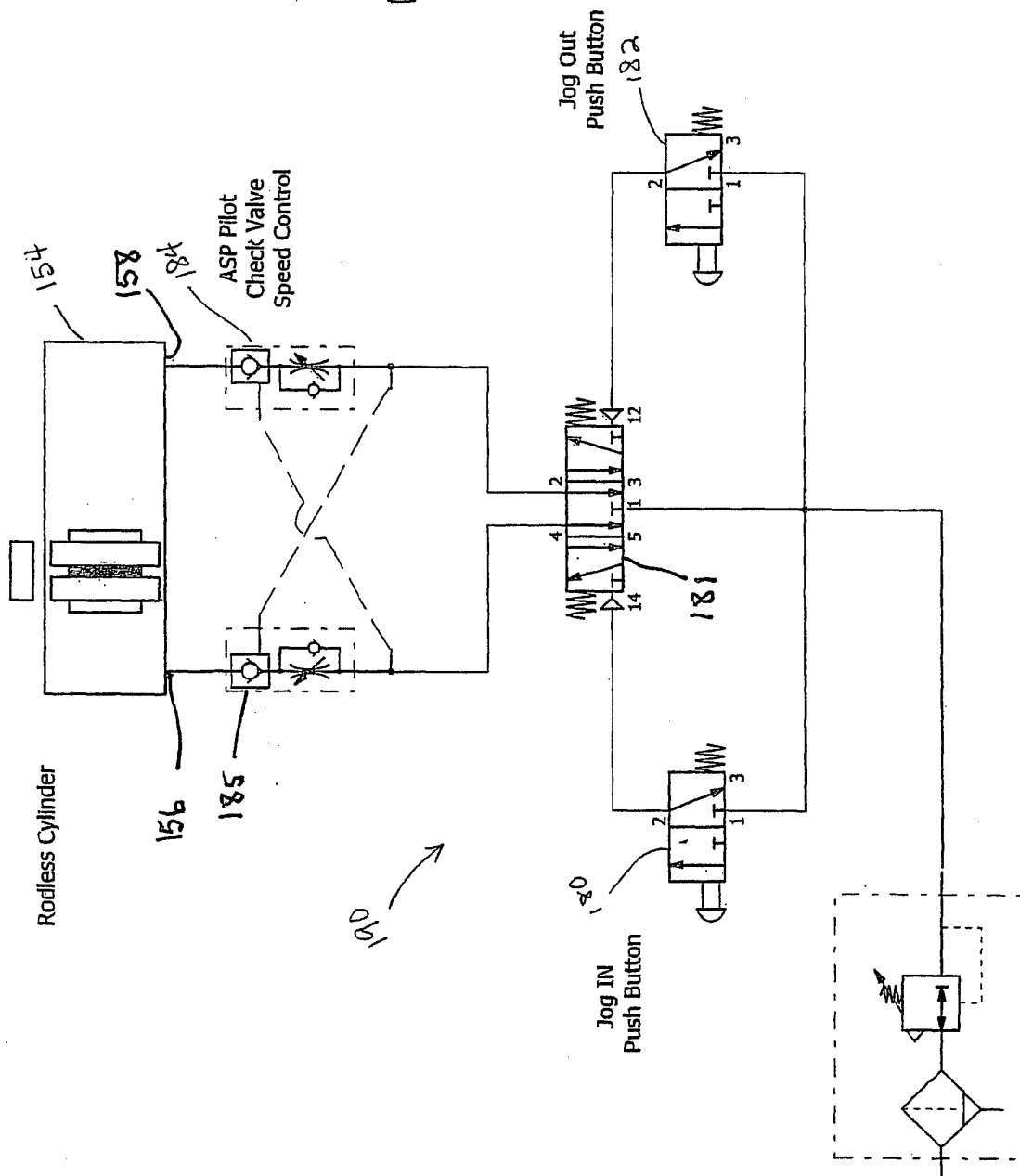


FIG. 6d

Fig. 8



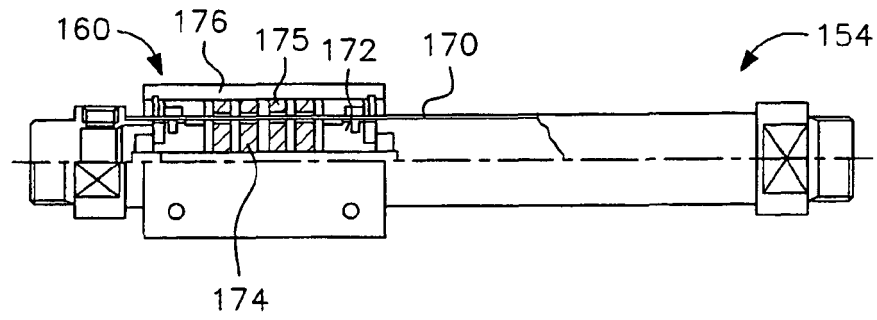


FIG. 7

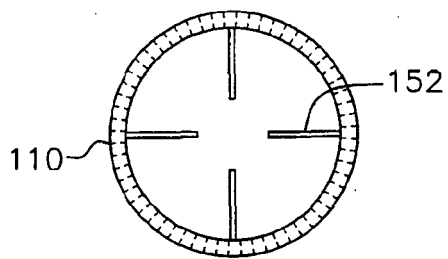


FIG. 9a

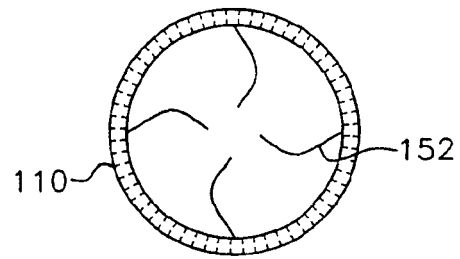


FIG. 9b

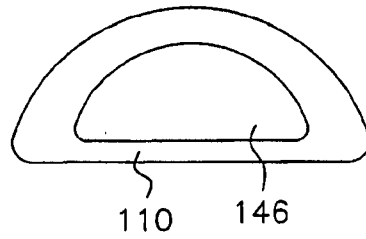


FIG. 9c

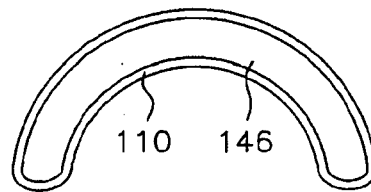


FIG. 9d

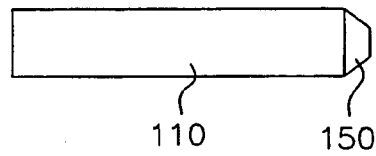


FIG. 9e

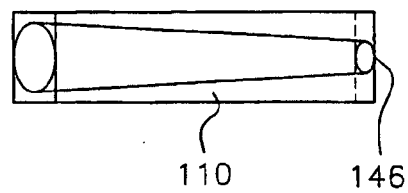


FIG. 9f

REFERENCES CITED IN THE DESCRIPTION

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